Trigger Software Diagnostics

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1. Execution times are monitored for each token. The average time can be displayed at any time during a run. The timer is the 8.333 MHz clock enabled in VME. The number of clock ticks can also be displayed for each token. The timer is started when (a) a DSM crate (or L1) receives a BUILD_EVENT command and is stopped immediately after the transfer of data to L2, or (b) when L0 takes the first word from the TCU Event FIFO and is stopped immediately after the BUILD_EVENT is sent either to L1 (Myrinet operation) or to the Data Concentrator (STP operation).

   For any DSM crate: dsm_Times (or L1_Times for L1) will give the following:
   BBC> dsm_Times
   Number of tokens: 4000
   Min_time 660, token 3585 (The time is given in clock ticks: 120 nsecs)
   Max_time 11427, token 2545
   Average DSM run time: 129.98 microsec
   DMA Error Counter : 0

   A similar display can be obtained for L0 with: L0_Times In this case, an additional summary is given for the time to L2_ACCEPT and also the time to L2_ABORT. This timer is started when L0 takes the first word from the TCU Event FIFO and is stopped on receipt of the ACCEPT or ABORT command from L2.

   For example:
   L0> L0_Times
   L0 execution time
   Number of tokens: 4000
   Min_time 198, token 2770
   Max_time 4585, token 3070
   Average L0 run time : 27.95 microsec
   L2 response time
   Number of tokens: 2320
   Min_time 8396, token 1701
   Max_time 36969, token 3080
   Average time to accept: 1466.06 microsec
   L2 abort time
   Number of tokens: 3999
   Min_time 8613, token 1488
   Max_time 54580, token 1280
   Average time to abort: 1303.26 microsec

   If the command is xxx_Times 1 then the time (in clock ticks) will be given for each token, followed by the summary shown above. (Now that 4000 tokens are in the system, this command will print a large amount of information. Not recommended.)

2. Run Control specifies *maxTknInSystem*. This is now (April 2006) set to 4000. It must be understood that this refers only to the number of tokens that can be used by

trigger and does not mean that all these tokens will be used by trigger at any one time. The number of tokens placed on the TCU FIFO is determined by L0 by means of a global variable: *throttle*. *maxTknInSystem* must be larger than *throttle* but otherwise its value has no effect on trigger rates (unless all 4000 tokens are being used in DAQ in which case, no further triggers will occur).

The RHIC clock rate is such that the DSM memory pointer will wrap round in (65536*RHIC clock period) msecs. This is about 7 ms. In order to avoid data corruption, it is essential that for any token, the readout of DSMs is completed within 7 ms. The time to L2_ACCEPT is used as a measure and should not exceed 7 ms.

For a single token in the system, time to ACCEPT is typically 420 μsecs with Myrinet, or 220 μsecs with STP. Let this time be T. If the trigger rate is such that the trigger period is significantly less than these times, then L0 will take tokens from the TCU faster than can be processed and events will be placed in a queue. Clearly the first event will be dealt with in T but the ACCEPT for the last in the queue will take significantly longer than T and, without appropriate action by L0, could exceed 7 msecs.

Consequently, L0 will not allow more than *throttle* number of tokens to be active in trigger, that is, awaiting an ACCEPT decision, irrespective of the definition of *maxTknInSystem*. The L2 ACCEPT time is monitored by the TCU software and if it exceeds 6 ms for any token, the value of *throttle* is automatically decreased by *delta_step* and a warning is sent to the Operator's monitor window. This action will continue until errors are no longer observed or a minimum value *minthrottle* is reached for *throttle*. (This minimum value is currently 3.) The amount by which *throttle* has been reduced (*delta*) can be determined in a live system by typing: L0_Dump. This command also presents additional monitoring information.

```
L0> L0_Dump
Token throttle    30
Delta throttle    20          Amount by which throttle has been reduced
Tokens available  4000        This is maxTknInSystem
Tokens_in_pool    3977        This is maxTknInSystem
Tokens_in_trigger 1           Number of tokens in trigger awaiting a L2_ACCEPT
Tokens_on_FIFO    9           Tokens on the TCU FIFO awaiting a trigger
Tokens in DAQ     13          ACCEPTed tokens now passed by L2 to DAQ
Tokens requested  439440      Events triggered so far
Token Empty       0           Number of times no tokens were available for TCU
Accept overtimes  34          Number of times L2_ACCEPT time has exceeded 6 ms.
Max overtime usec 191647      Maximum L2_ACCEPT time so far
Accepts now       256939      Number of L2_ACCEPTS issued
Aborts now        182491      Number of L2_ABORTS issued
Halt count        0           (Not active at the moment)
```

The single token ACCEPT time can be determined simply by setting *throttle* to 1 and *delta_step* to 0. The *throttle* and *delta_step* variables are set to 30 and 5, respectively, when L0 is re-booted. If these are changed manually, they should be reset manually unless L0 is re-booted.